VI. *An Investigation of all the Changes of the variable Star in* Sobieski's *Shield, from five Year's Observations, exhibiting its proportional illuminated Parts, and its Irregularities of Rotation; with Conjectures respecting unenlightened heavenly Bodies.*

By Edward Pigott, *Esq. In a Letter to the Right Hon. Sir* Joseph Banks, *K. B. P. R. S.*

Read February 7, 1805.

Bath, 1802.

THE object of the first part of this Paper is a further investigation of the periodical and other changes of brightness of one of the variable stars I discovered in 1795, that in SOBIESKI'S *shield*, an account of which the Royal Society did me the honour of publishing in their Transactions. Those determinations being deduced from a few periods made *near the time of discovery*, must of course remain unsatisfactory, however exact the observations themselves may be, until *confirmed* by an additional set, or by others made at a greater interval of time; for which purpose I occasionally continued keeping a journal of its changes for near five years, and am happy to find that they have answered my expectation, particularly by giving us an insight into its irregularities, as will be shewn hereafter.

Variable Star in SOBIESKI'S *Shield.*

$$\left.\begin{array}{ll}\text{R. A. - -} & 279^\circ\ 9\tfrac{1}{2}' \\ \text{S. declination} & 5^\circ\ 56'\end{array}\right\}\text{for the end of June, 1796.}$$

Its rotation on its axis was, in 1796, estimated at 62¾ days, from a mean of six observations of its greatest and least brightness. Here follow about 26 similar determinations, most of them the results of very accurate observations; and as they probably will in future be compared with others, I have examined them repeatedly with the utmost care, attending particularly to the progression of their changes.

Table I.

Dates when at its greatest Brightness.	Magnitudes.	Dates, when at its least Brightness.	Magnitudes.
1796. September 17	5	1796. September 3	6
November 13	5—	October 22 -	6
1797. May 14: -	5+	1797. July 10 - -	5.6
August 7 -	5	September 15	6
October 15 -	6.5	November 6	6
1798. July 29 -	5+	1798. July 10 - -	6
October 25 -	5.6	September 15	9.0
December 5::	5.6	November 10	6
1799. June 1:: -	6.5	1799. July 4 -	7
August 7 -	5	September 16	6
October 11 -	5+	November 5:	6.7
1801. July 14: -	5	1801. June (middle):	6
September 24	5	August 21 -	6.7
		October 16 -	6.5

The + and — annexed to the magnitudes denote them to be more or less bright; the doubtful results are marked with dots; all the others are esteemed exact, except those of August 7, 1797, and August 21, 1801, which are in *a small degree* less so. From these determinations the rotation on its axis may be computed as follows.

Table II.

Middle of its greatest *Brightness.*

	Dates.	Interval in Days.				Number of Periods.
1796.	September 17 November 13	57	-	equal to	-	1
1797.	May 14 : August 7 -	85	-	=	-	1
	August 7 - October 15	69	-	=	-	1
1798.	July 29 - October 25	88	-	=	-	1
1799.	August 7 - October 11	65	-	=	-	1
1796. 1797.	November 13 May 14 : -	182 or 61—	- -	= =	- -	3 1
1796. 1797.	November 13 August 7 -	267 or 67—	- -	= =	- -	4 1
1797. 1798.	October 15 July 29 - -	287 or 57½	- -	= =	- -	5 1
1798. 1799.	October 25 August 7 -	286 or 57+	- -	= =	- -	5 1
1801.	July 14 : - September 24	72 :	-	=	-	1

Table III.

Middle of its least *Brightness.*

	Dates.	Interval in Days.		Number of Periods.
1796.	September 3 October 22 -	49	- equal to -	1
1797.	July 10 - September 15	67	- = -	1
	September 15 November 6	52	- = -	1
1798.	July 10 - - September 15	67	- = -	1
	September 15 November 10	56	- = -	1
1799.	July 4 - September 16	74	- = -	1
	September 16 November 5 :	50 :	- = -	1
1801.	August 21 - October 16 -	56	- = -	1
1796. 1797.	October 22 - July 10 -	261 or 65+	- = - - = -	4 1
1797. 1798.	November 6 July 10 - -	246 or $61\frac{1}{2}$	- = - - = -	4 1
1798. 1799.	November 10 July 4 - -	236 or 59	- = - - = -	4 1

From all these results it appears, that the disagreements between them are far greater when at its full brightness than at its least; I shall therefore, in summing up the first set, omit two of them, as they evidently differ considerably from the others.

Table IV.

Rotation from Observations of its full Brightness.	Rotation from Observations of its least Brightness.
Days.	Days.
57	49
69	67
65	52
61—	67
67—	74
57½	50
57+	56
72	56
	65+
	61½
	59
by its full brightness 63+ on a mean.	By its least ditto 59¾ on a mean.

A mean of these two means being 61½ days, agrees with the first deductions to 1¼ day, a coincidence that certainly I could not flatter myself would have happened: yet it must be remembered, that the intervals with considerable perturbations were omitted; for, had they been included, the length of period resulting from its *maxima* of brightness would have varied much more from that obtained from its *minima*. I shall now proceed to examine some of its other changes.

Table V.

Decrease from the Middle of its full Brightness to the Middle of its least. See Table I.			Increase from the Middle of its least Brightness to the Middle of its full. See Table I.		
1796.	September 17 October 22	35 days.	1796.	September 3 September 17	14 days.
1797.	May 14: July 10	57		October 22 November 13	22
	August 7 September 15	39	1797.	July 10 August 7	28
	October 15 November 6	22		September 15 October 15	30
1798.	July 29 September 15	48	1798.	July 10 July 29	19
	October 25 November 10	16		September 15 October 25	40
1799.	August 7 September 16	40	1799.	July 4 August 7	34
	October 11 November 5	25		September 16 October 11	25
1801.	July 14 August 21	38	1801.	August 21 September 24	34
	September 24 October 16	22			
		34 on a mean.			27+ on a mean.

The sum of these two means (61+), agreeing so satisfactorily with the whole rotation ($61\frac{1}{2}$), no correction is requisite, as was the case with the former determinations of 1796 to reduce them to 28 and 35 days, results that differ considerably from the above (34 and 27+); but as they were deduced from only *two* intervals, the disagreement cannot be of any consequence, provided the number of each set be *proportionally* attended to in the computation, and then the mean of the whole will be 33+ and 29— days: thus it appears that the *time of the decrease is longer* than that of the *increase*, and consequently that the places of the full and the least brightness are not situated at the distance of half the circumference from each other: the like circumstance will be found to be the case with most, if not all, of the variable stars. The next particulars to be reviewed are *the durations* of its brightness without *any perceptible change*, while at its *maximum and minimum.* These determinations require a tolerable *succession* of observations; where therefore that is not the case, they are omitted.

Table VI.

Duration of Brightness at its Maximum.			Duration of Brightness at its Minimum.		
	Days.	Magnitudes.		Days.	Magnitudes.
1796.			1796.		
September 17	9	5	September 3	7	6
November 13	8	5—	October 22	8	6
1797.			1797.		
October 15	32	6.5	July 10	24	5.6
1798.			September 15	18 :	6+
July 29	6	5+	November 6	6	6
October 25	10	5.6	1798.		
December 5	16 or more	5.6	July 10	12	6
1799.			September 15	9	9
June 1	16 : :	6.5	November 10	8	6+
August 7	8	5	1799.		
October 11	8	5+	July 4	9	7
1801.			September 16	10	6
September 24	15 : :	5	November 5	16 :	6.7
			1801.		
			October 16	9	6.5

It appears in general by my journal, and from these results, that when *the degree* of brightness at its maximum is *less than usual,* and its minimum *not much decreased,* the changes take place but very slowly, and cannot be settled with much accuracy, unless the observations have been made frequently, and with great attention; therefore, in summing them up, I think four of the first set and three of the second may be omitted, and then the duration at its maximum will be on a mean 8 + days,
and ditto 20 — days
when it does not attain its usual brightness;
and at its minimum - - - on a mean 9 — days,
and ditto 20 — days
when its decrease is not so great as usual; the former observations make them 14 and 9 days.

Some of its *degrees* of brightness annexed to the results, have occasionally been noticed, as far as it was necessary, but the list of them I am going to give, is more exact and full. It will be there seen, that its brightness is seldom the same for two or three successive periods; that the change in half a rotation is sometimes from the 5th to the 7th magnitude, and sometimes only half a one or scarcely perceptible: its decrease has also been greater than by the former observations, particularly on September 15, 1798, and August 9, 1803,* when it was less than the 9th magnitude, or had even disappeared.

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* Added since the Paper was written.

Table VII.

Dates.	Magnitudes when at its full Brightness.	Dates.	Magnitudes when at its least Brightness.
1796. September 17	5	1796. September 3	6
November 13	5 small	October 22 -	6
1797. May (middle)	5 bright	1797. July 10 -	5.6
August 7 -	5	September 15	6 bright
October 15	6.5	November 6	6
1798. July 29 -	5 bright	1798. July 10 -	6
October 25	5.6	September 15	9 or 0
December 5	5.6	November 10	6 bright
1799. June 1 -	6.5	1799. July 4 -	7
August 7 -	5	September 16	6
October 11 -	5 bright	November 5	6.7
1801. July 14 -	5	1801. June (middle)	6
September 24	5	August 21	6.7
		October 16	6.5
		1803. August 9* -	9 or 0

In concluding these determinations I shall collect together, as follows, in one view, all the different changes that have been examined; the first column describes them, the second exhibits the present results, the third the former ones, and the last column a mean of both, computed *proportionally* according to the number of observations of each.

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* Added since the Paper was written.

Table VIII.

	Days.	Days.	Days. on a mean.
Rotation on its axis - - -	61½	62¾	62—
Duration of brightness, at its maximum, without any perceptible change -	8+	14	9½
Ditto, when it does not attain its usual brightness - - - -	20—	—	—
Duration of brightness at its minimum, without any perceptible change -	9—	9	9
Ditto, when it does not decrease so much as usual - - - -	20—	—	—
Decrease in time, from the middle of its full brightness to the middle of its least - - - - -	34	28	33+
Increase in time, from the middle of its least brightness to the middle of its full - - - -	27+	35	29—
Extremes of its different degrees of brightness; with a mean of its usual variations - - - -	5+ 9 or 0	5+ 7.8	5. 6

SECOND PART.

Fontainbleau, 1803.

These essential variations of the star being thus settled with considerable precision, we may proceed to examine some of its other phenomena, particularly one common to most of the variables, as likewise in some degree to our sun, *viz. that the times of their periodical returns of brightness* are, in general, IRREGULAR, a circumstance I apprehend sufficiently interesting to engage our attention, at least I have ever thought so, and was thereby induced a few years past to make a succession of observations on one of them, in hopes of finding in what manner such *irregularities* took place, or at least to leave to future astronomers determinations, that might lead them to form some ultimate opinion thereon. I therefore chose for that purpose the star in SOBIESKI'S *shield*, on account of the time of its revolution on its axis being comparatively of a moderate length, *viz.* 62 days, and shall here have the honour of laying before the Society the appearances that occurred, point out the various results deduced from the observations, and attempt to explain them. The two following Tables are the observed middle times of its *full* and *least* brightness, with deductions of the star's apparent rotation from *single intervals*, which in the present examination can alone be admitted, because a mean taken of two or several would in general make such irregularities disappear, by the long and the short ones compensating each other. The remarks for the present need not be attended to, as they are chiefly to explain the reliance that may be put on some of the observations.

Table IX.

The observed middle Times of its *full* Brightness.	Apparent Rotations in Days.	Remarks, chiefly to illustrate some of the Observations.
1795. October 1 -	70	By the observations of November, &c. it seems probable it had not obtained its full brightness before December 10, although possibly much later.
December 10:		
1796. April 10 -	69	
June 18 - -	39	The increase towards July 27 was so slight that I had much hesitation in adopting it as a full brightness; if omitted, the interval will be 91 days. See Phil Trans. 1797.
July 27 -	52	
September 17 -	57	
November 13		
1797. May 14: -	85	The full brightness in May is doubtful to only about 6 days; the observations afterwards, to August the 7th, were made with tolerable regularity.
August 7 -	69	
October 15 -		
1798. July 29 -	88	A regular succession of observations were made between July and October 25.
October 25 -	41	The last observation made, was on December 10, when it shewed no appearance of decreasing, although it had been 16 days at its full brightness.
December 5:		
1799. June 1: -	67	The full brightness lasted a fortnight.
August 7 -	65	
October 11 -		
1801. July 14: -	72	The observation of July 14, is doubtful to a few days, to which perhaps the excess may be attributed.
September 24	38	A regular succession of observations were made between September and the middle of November. This last determination was deduced after the first part of this Paper was finished.
November 1		

Table X.

The observed middle Times of its *least* Brightness.	Apparent Rotations in Days.	REMARKS, chiefly to illustrate some of the Observations.
1796. March 4	67	
May 10	70	The decrease of July 19 being so very slight, I for a long time omitted it, and took the interval from May to September of 116 days as a double revolution, but have here preferred the separate ones of 70 and 46 days. See Phil. Trans. 1797.
July 19	46	
September 3		
October 22	49	
1797. July 10	67	
September 15	52	
November 6		
1798. July 10	67	
September 15	56	
November 10		
1799. July 4	74	The increase and decrease observed by a succession of good observations.
September 16	50	
November 5:		
1801. Middle of June::		
August 21	56	
October 16		

It thus appears, that the periodical returns of brightness are uncommonly fluctuating, and that the differences between the extremes are very considerable; to account for which, I shall presume to offer the following explanations, suggesting previously a few plausible conjectures, and some inferences arising from the observations themselves.

1st. That the body of the stars are dark and solid.

2d. Their real rotations on their axes are regular.

3d. That the surrounding medium is by times generating and absorbing its luminous particles in a manner nearly similar to what has been lately so ingeniously illustrated by the great investigator of the heavens, Dr. HERSCHEL, with regard to the sun's atmosphere.

4th. That these luminous particles are but *sparingly dispersed* in the atmosphere surrounding the variable star of SOBIESKI, appears from the star being occasionally diminished to the 6.7 magnitude, and much less. July 4, 1799, it was of the 7th; September 15, 1798, and August 9, 1803, *of the 9th, if not invisible.* (See Table VII.) Does not this indicate a very small portion of light on its *darkened hemisphere?*

5th. And may we not with much plausibility consider them as spots, somewhat circular, or of no great extent? for even on its *brightest hemisphere* the *duration* of its full lustre is, on a mean, only 9½ days of the 62, or about one-sixth and ½ of its circumference. (See Table VIII. page 140.) The dimensions therefore of the parts enlightened seem much circumscribed, and can be tolerably estimated, and consequently may be represented very small, particularly if the *powerful effect of a little light* and *the length of time* a bright spot is remaining in view be taken into consideration.

6th. And a further ground of presumption that those principal bright parts are but slight patches is, that they undergo *perpetual changes*, and also that such changes are very visible to us, for most probably they would be imperceptible, were not the bright parts contrasted by considerable intervals or diminutions of light.

7th, and last. We may obtain some idea of the *relative situation or intervals between* these bright parts, by the observations of the increase and decrease of brightness, as thereby the changes and times elapsed are pointed out. (See Table V. page 136; and Phil. Trans. for 1797.)

I have tried practically the effect of the above suppositions, by placing small white spots on a dark sphere, which being revolved round represented the various changes as nearly as could be expected: proceeding therefore with these and other considerations, I shall make ideal drawings of the star with the small illuminated parts in its atmosphere, and apply to them some of the actual observations from both the preceding Tables, having always in view that each period may, more or less, require a different disposition of spots, in consequence of their constant changeability.

1st *View.*

Plate II. Fig. 1, A B, the star's polar axis, round which its rotation takes place in 62 days from C to D.

CD, its equator, the 360 degrees of which being revolved in 62 days, gives nearly 5¾ degrees for each day's motion; the brightest part or spot is represented as centrally facing us, and accordingly shewing the star in its greatest lustre. Were this bright spot and the other parts to remain *unchangeable* they would after having completed the revolution of 360 degrees or 62 days, (the star's rotation on its axis,) appear again as at first, and at every return continue to give exact periodical times, as was nearly the case in 1799 between August and October, (See Table IX. p. 142,) but if the spot becomes obscure and another brightens up in a different place, this latter will make the star appear at its next full splendour either sooner or later than the real rotation according to its position, thus,

2d View.

Fig. 1. A full brightness having been shewn by the same spot, it afterwards loses its light and another as bright is produced 5 days motion (or 29 degrees) preceding it at E, see Fig. 2. This latter, when turned centrally to the earth, will appear 5 *days sooner* than the former one, now obscured, (here marked P,) and show the star at its full lustre, making the rotation 57 days instead of 62, which was the case in 1796, the observed revolution between September 17 and November 13. (See Table IX.)

3d View.

Fig. 3. We will now apply a case of an interval of too great length, that of 72 days: the spot *m* alone having shewn us the star in its full lustre, its light disappears during the revolution, and another brightens forth ten days (or 58 degrees) *following it* at H; when *m* returns to face us again in 62 days it being obliterated, the star will still appear obscured, and not recover its splendour until the new brightened part H becomes central, which being *ten days later* than the position in which *m* was seen, makes the revolution 72 days instead of 62, as was observed between July 14 and September 24, 1801. (See Table IX.) In the above case the alterations took place while behind the star, otherwise some irregularities would have been perceived, as will later be noticed. The same reasoning with proper alterations will, I apprehend, account for the other revolutions, yet I shall soon again resume the subject with

regard to a *series* of the greatest irregularities; at present let us proceed to take a few views of the intervals of its *least brightness*, which, contrary to my expectation, I find much more difficult to explain than those of the full, although the results disagree less among themselves. The darkened face of the star is here represented with a few small changeable bright spots, placed in general, at a proper distance, so as to keep up an uninterrupted increase and decrease of light with regard to us, and are also made to correspond with several other observations.

4th View.

Fig. 4 is to explain the greatest interval, of 74 days, between July 4th, and September 16th 1799. (See Table X.) The darkened hemisphere here exhibited is its *minimum* July 4th, with the following spots, *w* nearly gone off, next a small one *l*, then another P of a similar size, preceding the centre a day or two, (or a few degrees,) and lastly a bright one at D, just appearing. During the rotation, D losing its light and the P becoming *much brighter*, the star at its next return in 62 days, when at its first position, must of course appear much brighter, (See fig. 5) but by the retiring of *l* and P continues to diminish in lustre till the appearance of some large spot from the other hemisphere; which taking place 12 days afterwards, will, (when this time is added to the 62 already revolved) make the revolution of 74 days, as required; for a view of a short interval, for the present let that of 56 days be taken, between August 21st and October 16th 1801. (See Table X.)

5th View.

The least brightness or *minimum* is represented by fig. 6, when the bright spots *y* and *x* at each extremity of the equatorial diameter are mutually but just in sight and a minute one, *r* alone on its surface preceding *y* by 6 days motion: *n n*, are other middling sized spots near *x*, but preceding it; they cannot for the present be seen, being on the opposite or bright hemisphere. The spot *x* during the stars revolution having lost its light, and *r* being considerably increased, the next *minimum* will be between *n n* and *r*, (instead of *x* and *y*.) See fig. 7; and by the retiring of *n n* the *diminution* of the star's light will continue to take place only until the reappearance of *r*, at the place where *y* was, which being 6 days sooner than the former position, (See fig. 6,) reduces the rotation to 56 days. All the foregoing views are from unconnected periods, where only the ultimate returns of each appearance have been attended to; but now, I shall examine a long interval with many intermediate changes, that between June 18th, and September 17th 1796, wherein are included the most intricate irregularities and vicissitudes: these observations are already printed at full length in the Philosophical Transactions for 1797, and therefore can at any time be inspected: indeed, I then little thought they would ever become of further use, but that of stating facts, to which, however, I have always been very partial, and particularly so, after having experienced the advantage of Maraldi's printed observations on the variable star in Hydra, as it was partly by them that I ascertained the periodical returns of brightness of that star, and which flattered me the more, as Maraldi himself had been less successful in the attempt; See Phil. Trans. for 1786. Yet in the present Paper I have omitted all such details, being aware they might be thought too voluminous, but hope at some future time the Society will honour them with a place in their library.

The first sketch, Plate III. represents, for June 13, 1796, the comparative size of the bright spots supposed to surround the star, but here extended at full length; the next eight following are spherical views, on an enlarged scale, for each quarterly rotation or less, shewing the principal changes, as expressed in the adjoining remarks, and corresponding with the observations; these being taken from my printed paper, as already mentioned, are marked in italics. It will be seen that the spots by which the changes are principally regulated, are placed at equal distances, yet intermediate ones might also frequently be inserted without occasioning any objection, but that of rendering the explanations more complex.

REMARKS ON PLATE III.

Fig. 2. "*June 18th. Full brightness Mag. bright 5th,*" before or after which date the star would appear less bright, by the spot E being removed from the centre, and one of the others out of view.

Fig. 3. "*July 3d, 15 days or* $\frac{1}{4}$ *rotation being elapsed since June 18th, 5th Mag. a little decreased*" by the removal of the brightest spot E, the *h* being much less.

Fig. 4. "*July 19th, 16 days or* $\frac{1}{4}$ *rotation 5.6 Mag. still decreased,*" N being much less than *h*, now gone off. *A slight minimum.*"

Fig. 5. "*July 27th, 8 days of the rotation, 5 Mag. rather* *increased*" by the considerable increase of N since four days, with the addition of F, *a slight full brightness.*

Fig. 6. "*Aug. 3d, 7 days of rotation, 5.6 Mag. decreased* by the going off of N, the E, which is now reappearing, being reduced to much less than F.

Fig. 7. "*Aug. 19th, 16 days or* ¼ *rotation, 5.6 Mag. again decreased,*" by the removal of F, by E being much less, and by the *h* also being considerably diminished.

Fig. 8. "*Sept. 3d, 15 days or* ¼ *rotation, 6 Mag. still more decreased,*" by the *h* being much less than E, which is now going off, and N scarcely reappearing, *another minimum.*

Fig. 9. "*Sept. 17th, 14 days or near* ¼ *rotation. 5 Mag. full brightness considerably increased,*" by N having retained its increased brightness of July 27, and now facing us centrally.

1st, Thus are exhibited, the two short intervals of its full brightness, one between June 18 and July 27, of 39 days, and the other between July 27 and Sept. 17, of 52 days. See Table IX.

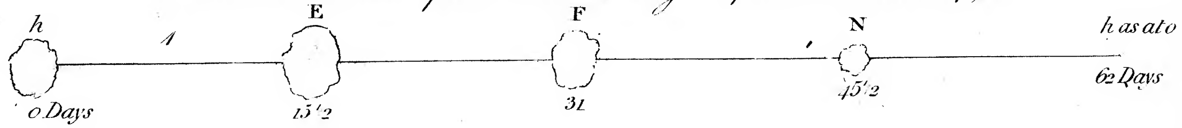
2dly, The interval of 46 days between the two *minima* of July 19 and Sept. 3; See Table X.

3dly, The long decrease of 38 days between July 27 and Sept. 3, and

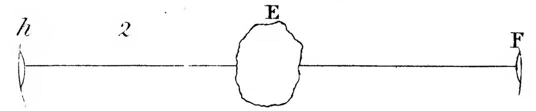
4thly, The rapid increases of 3 and 14 days between the 19 and 27th of July, and the 3d and 17th of September,

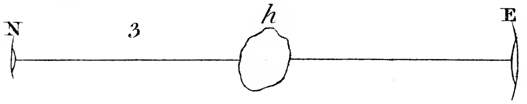
As also the other intermediate changes, yet I must again repeat, particularly as a few days error may occasionally proceed from the observations, that by these sketches it is not meant to give exact drawings of the size, distances or alterations of the spots, but merely to shew how the changes may take place, as, I believe, nothing of the kind has hitherto been

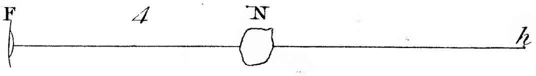
An extended view of the Surrounding Spots June 18th 1796.

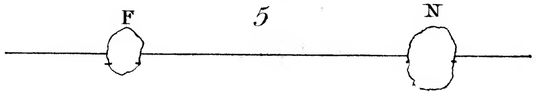


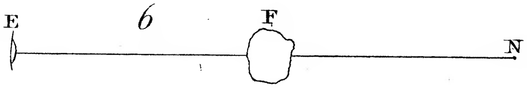
Spherical Views

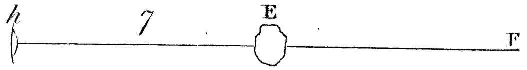


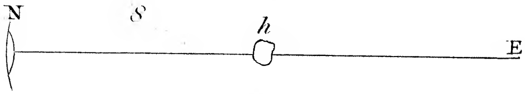


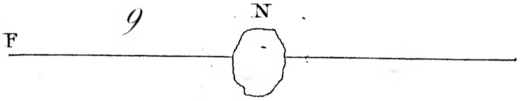












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offered to the public, either with or without corroborating observations; nor do I presume to think, that the explanations are the only ones or best that can be imagined, the more so, as they solely refer (for greater simplicity) to the star's equator, while possibly, were the spots placed in a northern or southern latitude, or permanent ones near the poles, or were a proper inclination, given to the polar axis, they might be more satisfactory: however, the materials themselves, the *observations* and *deductions* will I flatter myself ever be acceptable, and contribute to facilitate future conjectures, which from an allowable analogy may extend to similar parts of the starry system, with regard to the probability of establishing whether any of the most *irregular or particular* changes may not *return at fixt periods*, or after a certain number of rotations. I think we can entertain but slight hopes of it, owing to the *great fluctuation* of the luminous matter, as shewn by the *perpetual varying* of the *apparent* revolutions, magnitudes &c. See Tab. IX. X. and VII. Still it is natural to suppose, that some parts of the atmosphere of this star may have a less tendency than others to become luminous, so as to promote at different times, similar appearances; and indeed this is strongly indicated by the *intervals* of the *minima* being far *more regular* than those of the *full brightness*, which, with other reasons induce us to suspect that even one of its hemispheres is less favourably constituted or qualified, than the other for the generating of these particles, although they do occasionally encroach on both sides, as appears by the observations between June and August, See Phil. Trans. for 1797, or the eight sketches of 1796, and likewise in 1797, see Tab. VII. when during *three months* it was only reduced to the 5 or 6 Mag. by which the degree of brightness that surrounded it, must have been nearly equal: had the causes of varying its light then ceased, it would ever have continued to appear as an unchangeable star of the 5 or 6 Mag. and such is the case of several others that *formerly have been variables*, but for many years retain a steady brightness, as β Geminorum, δ Ursæ majoris, α Draconis, and perhaps that in the Swan's breast, while others, after *shewing their changes*, have *entirely disappeared*, owing to a total absorption of light, as the famous one in Cassiopea, in Serpentarius of 1604, that near the Swan's head, and doubtless many more. Does not this induce us to presume that there are also others, that have *never shewn* a glimpse of brightness? Lastly, *new variables* may become so at different periods, by an unusual and partial increase or diminution of their bright parts, as not unlikely was the case of ο Ceti, Algol α Herculis, &c. for these stars being by times very conspicuous, their changes, had they been always equally great, might have been easily noticed by the ancient astronomers, who observed only with the *naked eye*. A few lines above, I mentioned the probability that there existed *primary* invisible bodies or *unenlightened stars* (if I may be allowed the expression) that have ever remained in *eternal darkness;* how numerous these may be, can never be known. Would it then be too daring or visionary to suppose their numbers equal to those endowed with light? particularly when we take into contemplation the ample set of bodies visible only by reflected rays, that appertain to our own system, such as the planets, asteroides, comets, and satellites. Do not these, although but of a secondary nature, lead us to venture on the foregoing more enlarged conjecture; and moreover to suspect, that the *enlightened stars* are those that have already attained the highest degree of perfection? granting, therefore, such multitudes do really exist, clusters of them, by being collected together as in the milky-way, must intercept all more distant rays, and if free from any intervening lights, they would appear as *dark spaces* in the heavens, similar to what has been observed in the Southern Hemisphere. That so few of these obscure places are perceived, may be attributed to their being obliterated by the presence either of some scattered stars, or of other slight luminous appearances.

I have thus fully investigated the nature of this distant sun, a single one among many millions, and scarcely perceptible to the sight, yet of no less importance than our own grand luminary. But ours is still supplied abundantly with resplendent particles, while SOBIESKI's variable star has them most sparingly dispersed over its sphere: a scantiness that apparently must occasion to its surrounding planets, constant vicissitudes of uncertain darkness, and repletion of light and heat. How far more enviable seems our situation! I mean that which we enjoy at present; there being strong reasons to believe, that the sun's luminous appearance has been at times considerably diminished; and I have little hesitation in conceiving that it may also be reduced at some future period to small patches, and then the apparent irregularities of its periodical rotations, which at present are only perceived by the observations of trifling dark spots, would become evidently conspicuous, particularly when seen at a distance as remote as the variable stars are from us. But such conjectural flights of fancy cannot too soon be dropt. I therefore shall conclude with observing, that these inquiries on the alterations of light of the stars have been so little discussed, that it is to be hoped they will not be discontinued; and although I have already troubled the Society with many papers concerning such changes, I nevertheless propose, ere long, having the honour of presenting them with one more, most probably my last, on this subject.

EDW. PIGOTT.

Fig. 1.

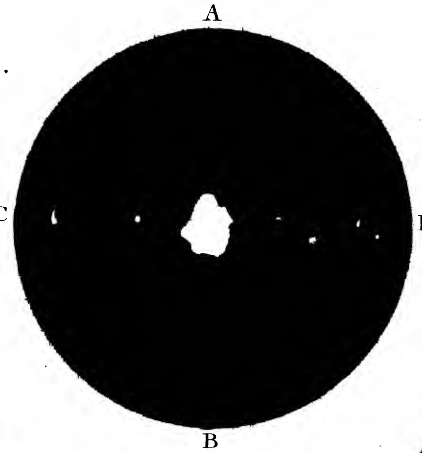


Fig. 2.

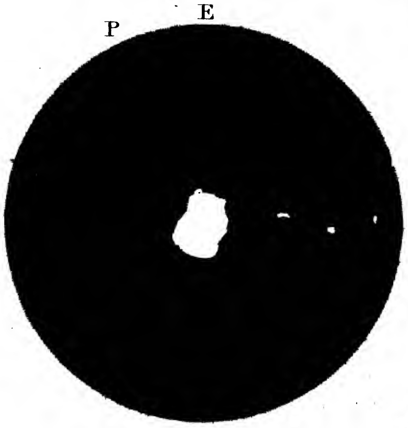
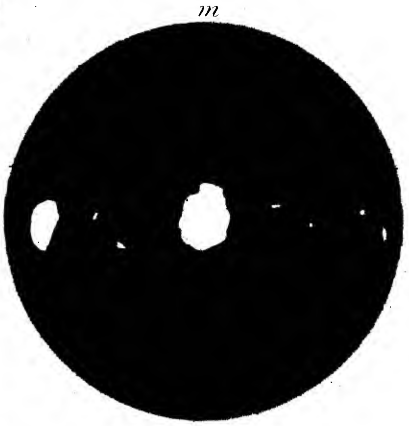


Fig. 3.



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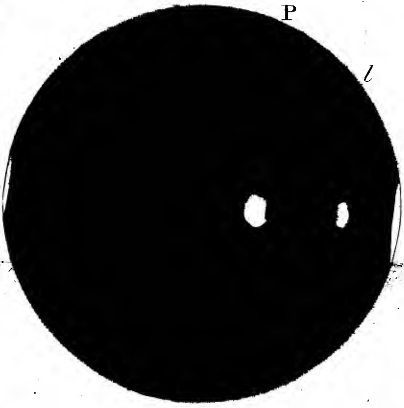

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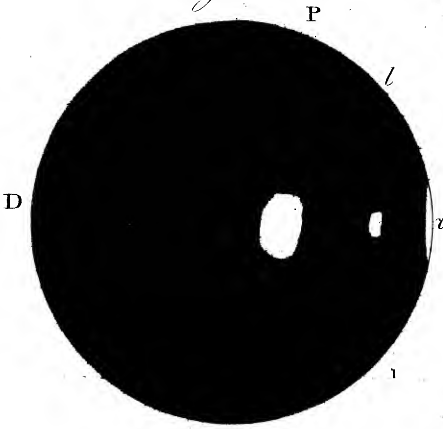


Fig. 6.

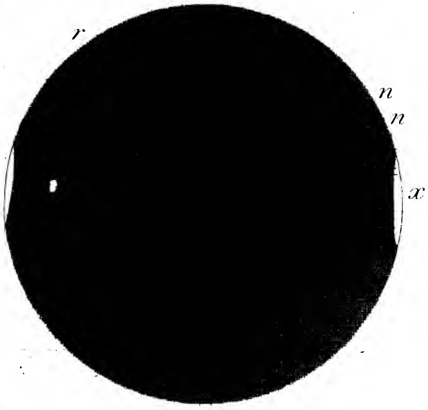
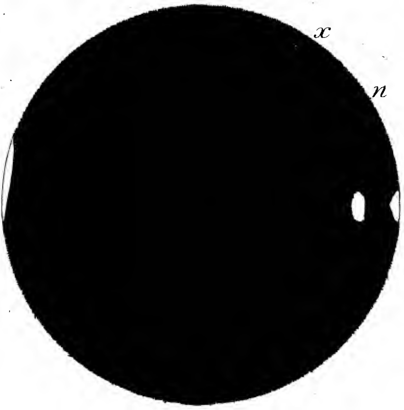


Fig. 7.



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